DOCUMENT RESUME

ED 028 259 VT 007 685

Arizona Industrial Arts: Electricity Electronics. A Curriculum Guide for Intermediate and Secondary Level Programs.

Arizona State Dept. of Public Instruction, Phoenix. Dept. of Vocational Education.

Pub Date 67

Note-55p.

EDRS Price MF-$0.25 HC-$2.85

Descriptors-*Electricity, *Electronics, *Industrial Arts, Instructional Aids, Intermediate Grades, Secondary Grades, *State Curriculum Guides

This curriculum guide is for use by teachers and its purposes are: (1) to describe the purpose and content of electricity-electronics courses, (2) to provide a suggested course outline with student and teacher activities and instructional aids, (3) to promote coordination between intermediate and secondary programs in Arizona, and (4) to suggest a foundation curriculum for trade and industrial education, technical education, and engineering. It was developed by a large group of teachers in a series of meetings which was coordinated by the state supervisors. "Exploring Electricity-Electronics" is a 45-hour unit and "General Electricity-Electronics," "Electronics," and "Advanced Electronics" are 180-hour courses. For each of these objectives are given, and course content, student activities, teacher activities, and instructional aids are organized in parallel columns for each topic. Supplementary materials include safety rules, visual aid bibliography, and a reference bibliography. (EM)

ED 028259

ELECTRICITY

ELECTRONICS

R. R. Witt

STATE
DEPARTMENT
OF
PUBLIC
INSTRUCTION

DEPARTMENT
OF
VOCATIONAL
EDUCATION

VT007685

ARIZONA INDUSTRIAL ARTS

ELECTRICITY ELECTRONICS

A Curriculum Guide for Intermediate and Secondary Level Programs.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Department of Vocational Education
State Department of Public Instruction
Phoenix, Arizona Fall, 1967

FOREWORD

This guide is the first in what will hopefully become a series of guides in Industrial Arts. It was developed through the cooperative effort of many Industrial Arts teachers.

The project was coordinated by Mr. William J. Anderson, State Supervisor of Industrial Arts.

A total of 44 volunteer teachers were involved in developing the guide. Subcommittees representing both the intermediate and high school segments of the curriculum worked as a team to provide articulation and coordination between the offerings at the elementary and secondary level.

A series of meetings were held during the 1966-67 school year and climaxed by a five day workshop at Westwood High School in June 1967. The workshop was funded from Title V of P. L. 89-10, the Elementary and Secondary Act of 1965.

Industrial Arts teachers are encouraged to constantly evaluate the suggested content and techniques for teaching in the guide in order that it may be revised periodically to include needed improvements.

A supplement is planned to be distributed at a later date. It will include suggestions for enriching and embellishing the Industrial Arts program of instruction including suggested equipment, commercially prepared units of instruction, and other teaching aids.

It is my sincere hope that the splendid spirit of team work and professional talent devoted to this project may establish the pattern for many similar projects in the years ahead.

J. R. Cullison

J. R. CULLISON, State Director
Vocational and Technical Education

ACKNOWLEDGEMENTS

The following teachers contributed to the development of this guide, all of whom volunteered personal time, effort, and travel expense. Workshop participants were selected by the general committee.

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INTRODUCTION

We are now living in what future historians may call the age of electricity-electronics. Few scientific, industrial, manufacturing or service fields have expanded at the phenomenal pace of electricity-electronics. The developments, to date, have produced many outstanding applications, but only the surface of this field has been touched. Today's amazing discoveries will seem commonplace in days to come. Applications of the principles of electricity-electronics are employed in all fields of endeavor and play an important role in our everyday lives.

With the coming of this new era there is a definite and immediate need for engineers, technicians, skilled workers, sales and service people and teachers in this field. Even the general public, the consumer, can greatly benefit from a degree of knowledge and the ability to safely and correctly use and care for electrical and electronic products.

On a national basis, this fast growing and diversified industry has enjoyed an annual growth rate of over 6% and an employment increase of 400% since 1950. In the decade 1965-75, total employment in Arizona will increase by about 50% or 250,000 jobs. Nearly 50,000 of these will require skills in the field of electricity-electronics. Consequently, the opportunities available to career minded young men and women are ever-expanding.

One of the primary purposes of the school is to provide the knowledge and practical learning experiences that will prepare its students for these opporutnities. This involves the task of stimulating the student's interest, creative ability, productivity and safe work habits. The total result should be that our boys and girls be well prepared for effective living in our modern society. Because of the almost universal use of electricity and electronics in our technological age the schools must include in the curriculum adequate instruction in electricity—electronics.

The objectives of this state curriculum guide are: (1) to provide a suggested course outline with student activities, teacher activities, and instructional aids which will be useful in organizing and teaching electricity-electronics classes in Industrial Arts; (2) to describe the purpose and content of the electricity-electronics courses; (3) to serve as an aid in coordinating existing programs in the intermediate and secondary schools throughout the state of Arizona; (4) and to provide a suggested curriculum that will serve as the foundation for electricity-electronics curricula in Trade and Industrial Education, Technical Education, and Engineering.

EXPLORING ELECTRICITY—ELECTRONICS

Electricity-Electronics in the intermediate level of industrial arts is an exploratory study of basic principles and an overview of related occupational requirements, conditions, and opportunities.

It consists of introductory experiences with the tools, instruments, materials, and equipment used by workers in this broad area of industry. Students will develop those basic skills and understandings that will provide the foundation for additional study.

OBJECTIVES

PLANNING

To develop the ability to plan basic electrical drawings (Procedures and interpretations).

SAFETY

To become aware of the dangers involved and to develop proper attitudes and safe practices in working with electricity.

INFORMATION

To explore the occupations, opportunities, qualifications, and future implications of the electricity-electronics industry.

SCIENTIFIC

To understand the theories, principles of operation, maintenance and methods of construction used in improving our lives through electricity.

COOPERATIVE VALUES

To develop a readiness to assist others and join willingly in all individual and group activities in the electricity-electronics shop-laboratory.

CONSUMER VALUES

To develop the ability to indentify information which will help the student become a better consumer of electrical products.

ACTIVITY

To develop the above objectives through laboratory experiences, manipulative skills, proper use and care of electrical tools and equipment.

EXPLORING ELECTRICITY-ELECTRONICS

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
I.* ORIENTATION	Shop tour. Cover Safety Rules and begin E-lectricity-Electronics notebook.	Present overview of course, emphasize safety and E/E shop procedures.	P.32-SAFETY RULES P.36-TRANSPARENCIES NO. 1
A. History, Development & Influence	This may be done by participating in reading, class discussion, etc.	Preview and show appropriate film.	P.33-F-1--"THE MIGHTY ATOM" F-6--"INTRO. TO ELECTRICITY" P.35-REFERENCES 3,5,6
B. Application in Home, School, Industry & Business	Reports by students on what their community would be like today without the discoveries of electricity.		P.33-F-10-"ELECTRICITY WORKS FOR US" P.35-REFERENCES 8,11
C. General Safety	Review safety rules. All students must pass examination on safety rules.	Lecture-Demonstration on overloading circuits, short shock dangers and first-aid. Maintain a continuous program on safety. File examinations for future reference.	P.33-F-2--"ELECTRICITY-PRINCIPLES ON SAFETY" F-3--"ON SAFETY WITH ELECTRICAL APPARATUS" P.36-TRANSPARENCIES NO. 1 P.25-REFERENCES 1,4,8,9
II. GENERAL NATURE OF ELECTRICITY			
A. Electron Theory	Begin work on a project such as a continuity tester. Read about the electron theory.	Outline procedures, theories, components and symbols applicable to project being constructed. (Emphasize proper use and care of electrical tools and equipment.) Demonstrate principles and techniques of soldering. Discussion on electrons in motion, positive and negative charges, etc.	P.33-F-7--"ELECTRONS AT WORK" F-8--"ELECTRONS" F-9--"PRINCIPLES OF ELECTRICITY" F-28-"ON SOLDER" P.36-TRANSPARENCIES NO. 1,2 P.35-REFERENCES 1,2,3,4,5,6,12

* See table of contents for suggested time schedule

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
B. Types of Electricity		Demonstration on production and effects of static and current electricity.	P.36-TRANSPARENCIES NO. 1 P.35-REFERENCES 1,8,11 P.33-F-5--"ELECTRICITY STATIC ELECTRICITY" F-11-"ELECTROSTATICS"
1. Static	Produce static electricity.		
2. Current			P.35-REFERENCES 1,5,11 P.33-F-4--"FLOW OF ELECTRICITY" F-23-"WHAT IS ELECTRIC CURRENT?"
a. A-C	Produce A-C with magnet and coil of wire. Observe direction of meter readings.	Using a zero-centered meter, demonstrate the generation of alternating current with magnet and coil of wire,	P.35-REF. NO. 12 (LEMON BATTERY
b. D-C	Produce D-C with battery (may use lemon and two dis-similar metals) or D-C generator. Observe direction of meter readings. Complete worksheet on electrical current. (for notebook)		
C. Conductors, Semi-Conductors and Insulators	Use continuity tester to demonstrate conductivity of various materials.	Demonstrate use and purpose of conductors, semi-conductors, and insulators.	P.36-TRANSPARENCIES 1,3 P.35-REFERENCES 1-12

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
D. Units of Measurement 1. Voltage 2. Amperes 3. Ohms 4. Watts	As equipment allows, participate in meter reading activities and complete work sheets.	Lecture and discussion on volts amps, ohms etc. Familiarize the Student with the use of measuring devices such as voltmeter, ammeter ohmmeter, kilowattmeter and multi-meter.	P.33-F-12-"AMPERES, VOLTS, & OHMS" F-13-"MEASUREMENT OF ELEC." P.35-REFERENCES 1-11 P.36-TRANSPARENCIES NO. 2
III. SOURCES OF ELECTRICITY A. Chemical (batteries) B. Magnetic (generators) C. Miscellaneous 1. Thermal (thermo-Couple) 2. Piezo-electric (pressure effect) 3. Photo-electric (photo-cells)	Student may rotate through experimental stations which demonstate the sources of electricity.	This unit is best covered by teacher demonstration.	P.33-F-15-"MAKING ELECTRICITY" F-16-"PRIMARY CELL" P.34-FS-1-"POWER FROM HYDRO-ELECTRICITY" P.36-TRANSPARENCIES 1,2,4 P.35-REF. 1-3,5,6,8,-12 REF. 1-11 (magnetic) REF. 1,3,6,8,9,11 (termal) REF. 1,3,6,8,11 (piezo-elec REF. 1,3,6,8,11 (phto-elec)

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
IV. EFFECTS OF ELECTRICITY			P.34-FS-2-"BASIC ELEC. SERIES" P.33-F-20-"EDISON'S MIRACLE - YOU ARE THERE" F-21-"THE LIGHT OF YOUR LIFE" P.36-TRANSPARENCIES 3,4 P.35-REF. 2,6,8,10 (heat) REF. 2,5,6,8,9,11 (light)
A. Heat B. Light	Explore how electricity is used to produce heat and light.-Wire a lamp and extension cord.	Discussion and demonstration on what effect resistance has on the flow of electrons resulting in heat and light. Give demonstration with nichrome wire to show resistance in creating heat.	
C. Electromagnetism 1. Motor 2. Generator 3. Controls	Make electromagnets and learn how they are employed in buzzers, solenoid, motons, etc.-Make electric motor project and learn to identify the important parts and their functions. (field, armature, commutator and brushes) optional projects.	Explain polarity in electromagnetism. Present activities designed to help student attain an understanding of how magnetism is used to produce electricity by cutting magnetic lines of force and how it is used to run a motor.	P.33-F-14-"MAGNETISM" F-17-"ELECTROMAGNETS" F-18-"PRIN. OF THE GENERAT F-19-"ELECTRICITY: HOW IT GENERATED" F-22-"MOTORS ON PARADE" P.34-FS-2-"BASIC ELEC. SERIES" P.36-TRANSPARENCIES 1,2,3 P.35-REF. 1-11 (electromagnetis
D. Chemical 1. Electroplating 2. Electrolysis		Teacher demonstration	REF. 3

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
V. ELECTRICAL CIRCUITS			
A. Basic Circuits 1. Power source 2. Load 3. Conductor path	Draw simple circuits	Present component section of any basic electrical circuit explaning source, control, transmission and load.	P.35-REF. 1-11 (power sources) REF. 1,4,8,9,11 (load) REF. 1,4,7,9,11 (conductor path) P.36-TRANSPARENCIES 1-4
B. Types of Circuits 1. Series 2. Parallel 3. Combination	This work may be covered using either teacher - student built circuit boards or commercial circuit boards.		P.35-REF. 1,4,7,11 (series) REF. 1,4,7,11 (parallel) REF. 1,2,4,8,10 (combinatio P.36-TRANSPARENCIES 1-3
		To make these experiences more meaningful, problems can be "built into" circuits so that simple trouble shooting activities can be performed.-Compare series and parallel to "and"-"or" circuits.	
VI. CONTROLS			
A. Switches-Electrical 1. Manual 2. Special	Student may construct a code practice buzzer or a code practice light, etc. Circuit board activity using switches.	Explain symbols and functions of manual and special switches.	P.35-REF. 1,3,6,8,10,11 (manual) REF. 6,8,11 (special) P.36-TRANSPARENCIES 1-3 P.34-FS-2-"BASIC ELEC. SERIES" P.35 REF. 2,3,5,6,8-11 (diode) REF. 3,5,6,8,10,11(transisto
V. Switches-Electronics 1. Diode 2. Transistor	Identify diodes and transistors. Laboratory experience to show how a diode acts as a one-way switch and how transistor conductivity changes according to voltage applied to base.	Explain symbols and functions of diode and transistors as switches.	

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
VII. ELECTRONIC COMMUNICATION SYSTEMS			
A. Introduction to Electronic Components (ie. resistors, capacitors etc.)	Complete worksheet of symbols & identification of electronic components.	Explain symbols, appearance & function of electronic components	P.33-F-24-"DEVELOPMENT OF COMMUNICATION" P.35-REF. 3,8,13 REF. 5,6,14
B. Radio 1. Tuning 2. Detection	Construct a simple diode detector.	Explain how a radio works.	REF. 3,8,10-14 P.33-F-29-"RECEIVING RADIO MESSAGES"
C. Introduction to Transistors	Construct a project or a circuit board activity, a simple transistor detector or transistor code oscillator.	Explain functions, types, voltage and heat limitations of semiconductors.	P.35-REF. 3,6,8,11,13-15
D. Transistor Amplification	Construct a project or a circuit board activity, a simple two (2) transistor amplifier.	Modules may be used in these activities for teaching concept theories.	REF. 3,6,14

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
VIII. OCCUPATIONS			
A. Electricity & Electronics Field	Research on occupational groups of industries and new developments.	Lecture-discussion on requirements for different occupations. Arrange for resource speakers from industries in the area.	P.35-REF. 3,10,11 P.33-F-25-"MY POP'S A LINEMA F-26-"ELECTRICIAN" F-27-"TELEPHONE AND TEL GRAPH"
B. Future Projections in Electricity & Electronics.		Presentation and discussion on achievements of today and tomorrow in electronics industries.	P.37-OCCUPATIONAL GROUPS P.35-REF. 8

GENERAL ELECTRICITY-ELECTRONICS

This curriculum is designed for students who have developed an interest in the broad field of electricity-electronics and who desire a full-year course. In-depth exploratory experiences are planned to help the student discover his tastes and talents and to make appropriate choices within his educational, avocational, and vocational plans.

THE SPECIFIC OBJECTIVES FOR GENERAL ELECTRICITY-ELECTRONICS ARE:

PLANNING

To develop desirable habits of orderly procedure in planning and completion of projects.

INFORMATION

To enable the student to make a more intelligent choice of vocational and leisure time activities.

SCIENTIFIC

To develop a basic interest and understanding of electrical-electronic theories and circuits.

COOPERATIVE VALUES

To develop a respect for others and a willingness to assist in individual or group projects.

CONSUMER VALUES

To develop consumer knowledge in the purchase, use and maintenance of electrical appliances.

SAFETY

To develop habits of safe practices and conduct in the use of electricity.

ACTIVITY

To be able to draw and interpret symbols and diagrams, and to understand the terminology of electricity-electronics.

To develop the ability to use and care for common tools, materials, equipment, and instruments used in electricity-electronics.

GENERAL ELECTRICITY-ELECTRONICS

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
* I. SAFETY PRACTICES AND BASIC SKILLS	Drill in first aid practices.	Demonstration of proper use of circuit protection; proper use of tools and equipment; first aid practice.	DEMONSTRATION BOARD FOR SHORT CIRCUIT EFFECTS
Personal safety procedures; proper use and care of tools and equipment - recurring during the year.	Drill in soldering practices. Record results of safety test for future reference.		P.39-F-1--"ABC OF HAND TOOLS" RED CROSS RESUSCITATION DUMMY
II. ELECTRON THEORY	Experiment with insulators and conductors.		P.39-F-2--"BASIC ELECT." F-3--"PRIN. OF ELECT." F-4--"WHAT IS ELECT." F-5--"ELECTRICAL SAFETY IN THE HOME" F-6--"SAFETY WITH ELECTRICIT F-7--"SOURCES OF ELECTRICITY
Atomic structure, valence bands, insulators, conductors and semiconductors.	Collect and display examples of conductors, insulators, and sources of power.	Demonstrate conductivity and insulation of various materials; basic sources of power.	REPRESENTATIVE COMPONENTS CHART OF BASIC SYMBOLS
Introduction & identification of the basic power sources: friction, piezoelectric, chemical, magnetic, & thermal symbols & schematic diagrams.	Drill in use of symbols & simple diagrams.		
III. RESISTORS	Name and identify various resistances.	Display and discuss various types of resistors.	DISPLAY BOARD OF RESISTOR COMPONENTS & RESISTANCE WIRE

* See table of contents for suggested time schedule

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
III. RESISTORS-cont. Construction of various types of load resistors: fixed, variable, wire, carbon; color code.	Drill on use of color code. Disassemble several resistors of different types.		
IV. BASIC MEASURING INSTRUMENTS Use of galvanometer, voltmeter, ammeter, ohmmeter and wattmeter in a circuit. Construction and operation of the galvanometer & the D'Arsonval movements. Types of scales & calibrations.	Connect and read various meters.	Demonstrate use of basic meters as to reading scales, circuit connections (polarity, series, parallel); meter movements.	METERS TRANSPARENCIES ENLARGED METER-FRONT MOCKUP P.39-F-8--"VOLT--OHMMETER OPERATION" F-9--"MEASUREMENT OF ELECTRICITY"
V. DC CIRCUITS AND CONTROLS Characteristics of simple series, parallel, & combination circuits. Use of Ohm's Law & basic Kirchoff's Laws.	Connect, measure & analyze various basic circuits (series, parallel & combination). Calculate simple circuit characteristics. Connect various control circuits.	Demonstration of the basic circuits using chalkboard, overhead projector, or other aids.	OHM'S LAW CHART P.39-F-10-"OMPS, VOLTS, & OHMS" F-11-"ELEMENTS OF ELECTRICAL CIRCUITS"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
V. DC CIRCUITS & CONTROLS-cont. Use of manual switches from SPST to 3 & 4-way multiple control circuits			
VI. EFFECTS OF ELECTRIC CURRENT Introduction to the use & applications of electric current to produce thermal, luminous, chemical & magnetic effects	Report on applications of electrochemical effects.	Demonstration of electrolysis and electroplating. Introduction to other effects of electron flow (to be expanded in later units).	P.39-F-12-"STORY OF THE MODERN STORAGE BATTERY"
VII. HEATING Characteristics of the heating effect of electric current: resistive, radiant, inductive & capacitive.	Connect various lengths & gauges of nichrome wire to power source & observe effects. Measure resistance of various heating elements. Check out and repair small heating appliances. (toaster, heater, etc.)	Demonstration of heating effect of current through resistive wire; radiant heating of infra red source high frequency inductive & capacitive heating.	P.39-F-13-"RF INDUCTIVE HEATING" F-14-"HIGH FREQUENCY SOLDERING" F-15-"INDUCTION HEATING" F-16-"RF HEATING"
III. MAGNETISM Characteristics & uses of permanent & electromagnets; including relays, solencids, generator & motor action.	Lab exercise showing effects of different factors in an electromagnet. Examine different materials for magnetic properities. Project (choice of one) (a)Relay (b)Solenoid(c)Electric	Review characteristics of magnetic fields of permanent and electromagnets. Demonstrate relay & solenoid action; motor & generator action.	P.39-F-17-"ELECTROMAGNETS" F-18-"PRINCIPLES OF ELECTROMAGNETISM" F-19-"PRINCIPLES OF MAGNETISM"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
IX. ALTERNATING CURRENT Characteristics & uses of AC, including terminology.	Plot sine wave from demonstration. Connect moving coil/magnet to a galvanometer & observe output. Connect low voltage lamp to DC and AC sources separetely & observe different voltages required to obtain same light output. Compute AC conversion of values.	Demonstrate generation of AC Sine wave; wave forms & frequency of different AC signals: relationship between E & I in a resistive circuit, & comparative measurements of alternating current.	P.39-F-20-"BASIC ELECTRICITY AC PARALLEL CIRCUITS" F-21-"BASIC ELECTRICITY AC SERIES CIRCUITS" F-22-"SERIES & PARALLEL CIRCUITS"
X. INDUCTANCE Characteristics, uses, & effects of self & mutual inductance.	Connect AC circuit with a variable inductance coil in series with a load & observe the effects. Measure voltage drop across several inductors & different frequencies. Draw a displaced sine wave of an induction circuit.	Demonstrate the effect of self-inductance in an AC circuit. (Phase angle, etc.) Display various forms of inductors Demonstrate the effects of combinations of inductors in series & parallel.	DISPLAY BOARD OF INDUCTORS P.39-F-23-"BASIC ELECTRICITY INDUCTORS IN AC CIRCUITS" P.40-F-24-"INDUCTANCE" F-25-"THE ELECTRON & INDUCTION" P.41-FS-1-"INDUCTANCE"
XI. TRANSFORMERS Characteristics & uses of transformers in AC circuits & automotive ignition systems.	Inspect & measure output voltages of sample transformers. Design small power transformer. Construct small power transformer. Connect automotive ignition system & operate in mockup form.	Demonstrate auto-transformer effect of single coil using various cores; isolation effect using two coils & various couplings (illustrate the relative efficiencies); step up/step down effect showing turns/voltage/current ratios; impedance matching effect.	P.40-F-26-"TRANSFORMERS" (theory) F-27-"TRANSFORMERS" (lab) F-28-"THE IGNITION CIRCUIT"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XII. CAPACITANCE Characteristics & uses of the various fixed & variable capacitors.	Examine different types of capacitors; drill on color code; measure voltage drop across several capacitors at different frequencies (in series with load); draw the displaced sine wave of a capacitive circuit - Project: R/C Flasher Code Oscillator	Demonstrate physical characteristics of various capacitors; electrical effects of capacitance in an AC circuit(phase angle etc); effects of combinations of capacitors in series & parallel.	DISPLAY BOARD OF CAPACITORS P.40-F-29-"BASIC ELECTRICITY CAPACITANCE IN AC CIRCUITS" F-30-"CAPACITANCE" P.41-FS-2-"CAPACITANCE"
XIIL LIGHTING Nature of light, the spectrum, & units of measurement. Characteristics & applications of incandescent, arc, fluorescent, gas discharge lamps.	Examine operational parts of various lighting systems; connect typical fluorescent lighting circuits; test & compute incandescent lamp ratings.	Demonstrate need for vacuum globe around filament of an incandescent lamp; effects of electron flow through gas discharge & fluorescent tubes; principle of arc light; use of light meter.	P.40-F-31-"LIGHT AND POWER"
XIV. GENERATORS Characteristics & use of AC & DC generators, & associated simple control systems.	Examine automotive generators & alternators; operate lab type generators and/or alternators & observe effects.	Demonstrate: factors involved in generation; physical makeup of DC generators & alternators; operation of basic regulation devices; output wave forms of different generators & alternators.	P.40-F-32-"PRINCIPLES OF THE GENERATOR" F-33-"MAGNETISM" F-34-"ELECTROMAGNETS" F-35-"PRINCIPLES OF THE GENERATOR"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XV. MOTORS Characteristics & use of AC & DC motors & associated simple control systems.	Examine automotive, universal, & AC motors. Project: (choose one) 2 pole DC motor 4 pole DC motor 2 pole synchronous AC motor 2 pole shaded pole AC motor	Demonstrate: factors involved in DC motors; physical & electrical makeup; operation of basic control circuits; factors involved in AC motors; physical & electrical makeup of AC motors; operation of basic control circuits.	P.40-F-36-"ELECTRIC MOTORS" F-37-"PRINCIPLES OF THE STARTING MOTOR" F-38-"SINGLE & POLYPHASE CIRCUITS" F-39-"ROTATING MAGNETIC FIELDS" F-40-"SQUIRREL CAGE ROTOR PRINCIPLE"
XVI. POWER & COMMUNICATION SYSTEMS	Connect telegraph & telephone circuits. Individual & group reports on special aspects of the various systems.	Discuss physical & electrical features, rate structures & applications of the various systems.	P.40-F-41-"YOUR VOICE & THE TELEPHONE" F-42-"TELEPHONE CABLE TO CUBA" F-43-"WINTER TOLL PATROL" F-44-"MORE THAN MEETS THE EYE" F-45-"COMMUNICATION" F-46-"DEVELOPMENT OF COMMUNICATION" P.41-F-47-"RAILROADING BY RADIO' F-48-"RADIO OPERATOR" F-49-"HOW WE GET OUR POWER"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XVII. PREVIEW OF ELECTRONICS Introduction to vacuum tubes, semiconductors, & their simple circuitry.	Connect simple half-wave rectifier circuit using vacuum tube and/or semiconductor. Connect simple voltage amplifier circuit using a vaccuum tube.	Demonstrate: operation of diode vacuum tube; operation of solid state diode; operation of triode vacuum tube.	P.41-F-50-"THE DIODE" F-51-"VACUUM TUBES: ELECTRON THEORY & DIODE TUBES' F-52-"PHOTO EMISSION" F-53-"VACUUM TUBES: TRIODE & MULTIPURPOSE TUBES' F-54-"PRINCIPLES OF THE TRANSISTOR" F-55-"TRANSISTORS, PART I"

ELECTRONICS

This is a full-year course recommended for all boys and girls who desire more advanced experiences in electronics. It is recommended that students have satisfactorily completed a general, electricity-electronics course. The purpose of this course is to give the student a detailed foundation of theoretical knowledge, instrumentation, and practical application of electronics. It also afford the student an opportunity to find out if he is suited for continued work in electronics and to determine the level at which he should prepare himself (repairman, technician, sales person, engineer, etc.). This electronics course offers excellent preparation to pursue additional education for a career or an avocational pursuit.

THE SPECIFIC OBJECTIVES FOR ELECTRONICS ARE:

PLANNING

To develop desirable habits and orderly procedures in planning, construction, and completion of electronic projects and installation.

INFORMATION

To acquire a knowledge of standards set up by the electronic industries.

To continue the study, understanding, and appreciation of vocational or avocational pursuits in electronics.

SCIENTIFIC

To develop an understanding of advanced electronic theories, circuitry, components, and troubleshooting procedures.

COOPERATIVE VALUES

To develop a respect for others and a willingness to assist in individual or group projects.

CONSUMER VALUES

To develop consumer knowledge in the purchase, use and maintenance of more complex electronic products.

SAFETY

To develop habits of safe practice and conduct in the use of electricity, electronic equipment, appliances and instruments.

ACTIVITY

To develop skills in the use and maintenance of electronic components, materials, tools, equipment, and instruments.

To develop the ability to apply mathematics to prove electronic principles and solve practical problems.

To acquire further knowledge of schematic diagrams and circuitry.

ELECTRONICS

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
*I. SAFETY PRACTICES AND BASIC SKILLS Personal safety procedures, proper use & care of tools & equipment--recurring during entire year, construction materials, symbols & schematic diagrams.	Drill in First-Aid practic Shop rules - Practice meter reading and hookup - Soldering practice - Hookup simple circuits from schematics.	Review safety rules - review basic meters - demonstrate soldering techniques - demonstrate building and punching chassis - record results of safety test for future reference.	P.42-F-1--"YOUR FUTURE IN ELECTRONICS" F-2--"ELECTRICITY: PRIN. & SAFETY" F-3--"ABC'S OF HAND TOOLS" F-4--"THE ELECTRONIC TECHNICIAN" F-5--"ON SOLDER"
II. ELECTRONIC INSTRUMENT Basic circuitry & uses of the VOM, VTVM, & the oscilloscope.	Practice the use of VOM, VTVM & Oscilloscope - Observe wave forms & Lissajous figures on the oscilloscope - Measure DC and AC voltages, RF & AF.	Give circuitry of voltmeter, ohmmeter, ammeter, shunted ammeter and explain how they are combined in a VOM - Give circuitry of VTVM; explain its use in high impedance circuit - Introduce use of oscilloscope; instruct in operation; demonstrate verstility for measurements.	P.42-F-6--"OSCILLOSCOPE DRAWS A GRAPH" F-7--"OSCILLOSCOPE: WHAT IT IS, WHAT IT DOES" F-8--"MEASUREMENTS OF ELECTRICITY" F-9--"CIRCUIT TESTING, ETC." OVERHEAD DEMONSTRATION MEATER MAGNET, SIGNAL GENERATOR MICROPHONE, AMPLIFIER

*See table of contents for suggested time schedules

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
III. POWER SUPPLIES Design, construction, & performance of the basic sources of power: chemical piezoelectric, photoelectric, thermocouple, vacuum tube, & semiconductor.	Measure voltage & current from various basic sources - Hookup half wave, full wave & bridge rectifier & observe on oscilloscope - Experiment with & observe the effect of filters & loading on a power supply - Construct power supply section of a superheterodyne receiver.	Explain power sources - Explain rectification & types of power supplies - Demonstrate with oscilloscope the effects of filters - Explane vacuum tube & semi conductor rectifiers; controlled rectifiers.	P.42-F-10-"THE DIODE: PRIN. & APPLICATIONS" F-11-"THE PRINCIPLE OF THE GAS FILLED TUBE" F-12-"VACUUM TUBES" DEMONSTRATOR POWER SUPPLY WITH FILTER, OSCILLOSCOPE, & VOM.
IV. BASIC DC CIRCUITS AND THEOREMS Characteristics & calculations pertaing to series, parallel, & combination circuits using Ohms Law & Kirchoff's Laws at a later time & need.	Set up various types of circuits; observe voltage & currents to prove Ohms Law and Kirchoff's Laws.	Review Ohms Laws, series, parallel and series-parallel calculations; Kirchoff's Laws.	P.42-F-13-"OHMS LAW" F-14-"SERIES & PARALLEL CIRCUITS"
V. AC POWER Characteristics, units & measurements.	Observe operation of alternator - Measure & compute RMS, peak to peak, peak, & average values of various voltages; compare with DC - Field trip to power plant.	Review: history, comparison with DC, generation methods, transmission, sine waves & frequency, voltage & current characteristics, transformation, RMS, peak, peak to peak, average measurements, frequency.	P.42-F-15'"AC THEORY, ELECTRICITY & MAGNETISM"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
VI. VACUUM TUBE FUNCTIONS Symbols, construction, & principles of operation & application to include: diodes-rectification, detection, switching, & multiplier circuits. Triode amplification & oscillation - Multi-grid & multi-purpose tubes.	Build simple single stage audio amplifier - Check detection, amplifier circuits of radio receiver - Experience in using signal generator & tube tester.	Show mock up or cut-a-way tube along with symbols & explansation of various types of tubes - Discuss problems of triodes which led to development of multi-grid tubes - Mention specialized tubes: thyratrons, klystrons, magnetrons, compactrons, etc.	CUT-AWAY TUBE P.42-F-16-"THE TRIODE: AMPLIFICATION" F-17-"CATHODE RAY TUBE" SWITCHING, MUTLIPLIER AMPLIFIER & OSCILLATO BREADBOARDS
VII. REACTANCE, IMPEDANCE & RESONANCE Characteristics, application, 7 calculations pertaining to inductive & capacitive reactance, impedance, & resonant circuits.	Experiment with inductors & capacitors in DC circuits; observe & solve for time constants - Experiment with inductors & capacitors in AC circuits; observe & solve for resultant voltages Observe inductance & capacitance at varying frequencies; resonance.	Review: AC & DC circuits; resistance, inductance, capacitance & time constant. - Introduce: inductive & capacitive reactance; vectors & impedance calculations- Drill in problem solving - Explain questions.	P.42-F-18-"INDUCTANCE" F-19-"INDUCED ELECTRIC CURRENTS" F-20,21-"CAPACITANCE" F-22-"RCL: RESISTANCE CAPACITANCE" F-23-"VECTORS"
VIII. AMPLIFICATION & AMPLIFIERS Characteristics & principles of audio, video, voltage, & power amplifiers.	Design & assemble a multi-stage audio amplifier; test & observe voltage relationships, waveforms, & amplification - Test differences in resistance, impedance, & transformer coupling - Add audio sections to the superheterodyne receiver - Field trip to Radio & TV Station.	Discuse: nature of sound; positive tube parameters; feedback; inverse feedback; loading; impedance matching; & decoupling - Wide band & R.F. amplifiers; classes of amplification - Voltage & power amplifiers - Hi-Fi & stereo amplifiers, tone controls, & volume controls.	P.42-F-24-"RADIO WAVES" P.43-F-25-"OSCILLATORS, AMPLIFIERS & RADIO"

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
IX. RECEIVER SYSTEMS APPLICATIONS Radio communication principles Stages of AM and/or FM radio Detectors, Oscillators, Tuners & Converters Transmitters	Build or complete Superheterodyne radio. Observe voltages, frequencies, & waveforms of a radio; align a radio. Build a simple transmitter; try various modulation systems. CAUTION: Do not connect any transmitter to an antenna (FCC regulations) Visit Radio - TV station	Discuss: communications & nature of radio signals; unmodulated carrier; amplitude modulation; frequency modulation; modulation methods; types of detectors; tuners, antennas, types of oscillators; TRF & superheterodyne receivers; ameteur radio & citizens band; television; teletype & facsimile.	P.43-F-26-"RADIO WAVES" F-27-"OSCILLATORS, AMPLIFIERS, & RADIO"
X. SEMICONDUCTORS Principles of operation of the semiconductor in its various forms & circuit applications to include diodes & transistors.	Construct single stage transistor amplifier. Observe voltage, current & waveform values - Construct code oscillator and/or single transistor receiver.	Introduce history; atomic structures; N & P types; P-N junctions; forward & reverse bias; transistor action; types of circuit configuration; diodes, transistors, integrated circuits.	PERIODIC TABLES P.43-F-28-"PRINCIPLES OF TRANSISTOR" TRANSISTOR MANUALS
XI. EMPLOYMENT & EDUCATIONAL OPPORTUNITIES Immediate employment versus advanced education in the field of electronics. Salary versus opportunity.	Library study of salaries & job opportunities in electronics; - student report Survey Arizona & U.S. Employment Service Publications.	Discuss enlarged earning power in electronics field with advanced education.	P.43-F-29-"YOUR FUTURE IN ELECTRONICS"

ADVANCED ELECTRONICS

This course is designed for the student planning to develop his avocational interests and/or become a technician or engineer in the field of electricity-electronics. The advanced experiences in this program will prepare the student for these post-high school curricual. Previous completion of a course in electronics is required.

THE SPECIFIC OBJECTIVES ARE:

PLANNING

To acquire additional knowledge of standards used in the electronics industries.

SCIENTIFIC

To develop an understanding of more sophisticated electronic components, circuits, systems, and devices.

COOPERATIVE VALUES

To develop a respect for and a readiness to assist others at school, home or industry.

CONSUMER VALUES

To develop the ability to critically evaluate electronic products and services.

SAFETY

To develop an awareness of safety for themselves and others as a way of life.

ACTIVITY

To develop the ability to use symbols, components, tools, equipment, and instruments - in more complex circuits.

To develop the skills necessary to troubleshoot, repair and maintair advanced electronic equipment.

To develop the ability to apply mathematics to prove electronic principles and solve practical problems.

To develop an interest in and the ability to design and construct circuits, and devices.

ADVANCED ELECTRONICS

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
* I. SAFETY PRACTICES AND BASIC SKILLS Class policies Personal & shop safety procedures-recurring during entire year.	Complete and pass a generalized shop safety test; specific tests when appropiate. Resuscitation practices	Demonstrate use of circuit protection devices; use & care of tools & equipment; safety & first-aid procedures - Record results of safety test for future reference.	EXAMPLES OF PROPER & IMPROPER CIRCUITS P.44-F-1--"ELECTRICITY-PRINCIPLES OF SAFETY" F-2--"SAFETY WITH EVERYDAY TOOLS" F-3--"ELECTRICAL SAFETY IN THE HOME" F-4--"SAFETY PRECAUTIONS FOR ELECTRONIC PERSONNEL"
II. SEMICONDUCTORS Principles of operations & circuits containing the semiconductor in its various forms. Diode: junction, zener, SCR, and tunnel Transistor: junction, thermistor, photosistor, unijunction, field-effect (FET), varactor, varistor	Hookup and test selected semiconductor circuits & devices.	Demonstrate forward & reverse characteristics of semiconductor junctions; zener point, negative resistance, SCR action, photosistor, varactor, varistor characteristics, and thermistor action.	"LIVE" MOCKUPS P.44-F-5--"PRINCIPLES OF TRANSISTORS" P.45-C-2--TRANSISTOR CIRCUITS

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
III. CIRCUIT THEOREMS Mathematical approach to the analysis & solution of resistive & reactive networks; decibel-power conversion; vector analysis.	Solve resistive network problems. Solve R-C-L network problems. Use log table to solve power-decibel conversions. Use vectors to solve CA circuit.	Review basic circuit rules, laws, & theorems for AC & DC circuits. Demonstrate the use of a log table for power level (decibels) measurement; use of vectors to solve AC network problems.	"LIVE" MOCKUPS FOR CIRCUITS CONTAINING R, X_C, and X_L P.45-T-1--ALTERNATING CURREN C-1--ALTERNATING CURREN
IV. TROUBLESHOOTING INSTRUMENTATION Basic circuitry & uses of RF & AF signal generators, signal tracer, signal injector, transistor checker, & the oscilloscope.	Select & properly use troubleshooting instruments to locate malfunctions.	Demonstrate and provide individual instruction in the use of the various troubleshooting instruments; also the several standard troubleshooting procedures.	OPERATION MANUALS FOR SPECIFIC INSTRUMENTS
V. RECEIVER CIRCUIT APPLICATIONS Basic AM, FM, and TV circuits to include testing procedures & alignment.	Troubleshoot, repair and/or align a AM or FM receiver. Troubleshoot, repair and/or align a TV receiver. Troubleshoot & repair a high fidelity audio system Adjust mechanical controls of a record player and/or tape recorder.	Review of differences between AM & FM modulation, band width, audio response, frequency deviation, percent of modulation. Review troubleshooting procedures & instrumentation. Demonstrate testing & alignment of an AM or FM receiver. Discuss purpose & operation of FM limiter, discriminator ratio detector, & the gated beam detector.	P.44-F-6--"THE TELEVISION SYSTEM" F-7--"TELEVISION RECEIVERS" F-8--"PRACTICAL TV ALIGNMENT" F-9--"TELEVISION-HOW IT WORKS" F-10-"BASIC PRINCIPLES OF FM" RADIO DEMONSTRATOR, AM & FM RECORD PLAYER

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
V. RECEIVER CIRCUIT APPLICATIONS - continued		Discuss action of TV receiver sections: RF & converter, vertical & horizontal sweep & sync, high voltage, deflection, CRT & composite signal. Demonstrate testing and alignment of a TV receiver. Demonstrate mechanical features of record players, & tape recorders, high fidelity monaural (or stereo audio systems).	HIGH FIDELITY STEREO AMPLIFIER SYSTEM TAPE RECORDER OR DECK TELEVISION SYSTEM
VI. TRANSMITTER CIRCUIT APPLICATIONS Basic AM & FM transmitter circuits & tuning principles.	Construct & test a low power oscillator circuit. Construct, tune & test a low power CW transmitter. Construct, tune & test a low power radiotelephone transmitter.	Present the AM transmitter in block form; CW & radiotelephone. Discuss the purposes & circuits of each section of an AM transmitter. Demonstrate the tuning & loading of a transmitter; FM transmitter in block form. Discuss the circuits & purposes of each section of an FM transmitter. Discuss the relative advantages of the AM & FM systems of radio communications.	P.44-F-11-"OSCILLATORS" F-12-"RADIO TRANSMITTER PRINCIPLES"

COURSE CONTENT	STUDENT ACTIVITY	TEACHER ACTIVITY	INDUSTRIAL AIDS
VI. TRANSMITTER CIRCUIT APPLICATIONS - continued		Explain how both AM & FM systems are used in television. CAUTION: Do not connect any oscillator or transmitter to an antenna (FCC regulations).	
VII. ELECTROMAGNETIC RADIATION Propagation, antenna, transmission lines, impedance matching.	Select & safely install an outside antenna. Complete frequency to wavelength conversions. Compute antenna & tuned transmission line lengths. Transmission line, source, & load impedance matching. Measure standing wave ratios of a transmission line.	Discuss the radio frequency spectrum & how electromagnetic radiation takes place. Discussion of antennas: types orientation, gain, radiation patterns, dimensions, radiation resistance, harmonics. Discussion of transmission lines: types, impedance matching, harmonic operation, standing waves, installation & safety precautions. Illustrate antenna & transmission line computations & antenna feedpoints.	P.44-F-13-"ELECTROMAGNETIC WAVES" F-14-"EFFECTS OF THE IONOSPHERE ON RADIO WAVE PROPOGATION" F 15-"MIRROR IN THE SKY" F-16-"TRANSMISSION LINES F-17-"STANDING WAVES ON TRANSMISSION LINES P.45-T-2--ANTENNAS MOCKUP TO DEMONSTRATE ANTENNA STANDING WAVE & RADIATION PATTERNS

COURSE CONTENT	STUDENT ACTIVITY	TEACHER ACTIVITY	INSTRUCTIONAL AIDS
VIII. INDUSTRIAL ELECTRONIC CONTROL SYSTEMS Principles of operation & application of various control systems.	Hookup & test: photo-cell control circuit; time delay control circuit; proximity alarm circuit; electronic tachometer; synchro system.	Present nomenclature & symbols used in industrial electronics. Demonstrate gas-filled & mercury pooled rectifiers; poly-phase rectifier circuits; electrostatic precipitators & safety precautions; industrial X-ray machines & safety precautions; induction & dielectric heating systems; basic principles of a servo system; inductive & capacitive spot welding systems; Demonstrate sequential timing control systems; thyratron & silicon controlled rectifier (SCR); gaseous voltage regulators; application of electronics in medicine.	SAMPLES OF MV RECTIFIERS THYRATRONS, MERCURY POOL RECTIFIERS, ETC. WORKING MODELS OF INDUCTION & DIELECTRIC HEATING SYSTEMS, & ELECTRONIC SPOT WELDERS P.44-F-18-"AUTOMATIC MACHINES

COURSE CONTENT	STUDENT ACTIVITY	TEACHER ACTIVITY	INSTRUCTIONAL AIDS
IX. MICROWAVE SYSTEMS Principles of operation & application of basic circuits for communications & radar.	Construct: UHF oscillator, UHF receiver, UHF directional antenna. Measure the power output & wave length of a UHF oscilator.	Discuss comparsions between microwave & lower frequency radiations. Discuss: skin effect, wave guides, coaxial cables, & cavity resonators. Discuss & demonstrate microwave generators. Discuss & demonstrate microwave receivers. Discuss microwave antennas. (launchers) Discuss the conventional & Doppler radar systems.	MICROWAVE DEMONSTRATOR UNIT SAMPLES OF WAVE GUIDES, CAVITY RESONATORS, KLYSTRONS, MAGNETRONS, ETC. P.44-F-19-"RADAR AND TV" F-20-"COAXIAL & MIRCRO-WAVE MIRACLES" P.45-T-3--RADAR
X. BASIC COMPUTER SYSTEMS Principles of computer mathematics, operations & basic circuits.	Hookup & operate a basic passive analog computer circuit. Convert digital to decimal codes & vice versa. Hook up a simple logic circuit: "adder", "and", "or" and "nor" configurations.	Discuss capabilities & limitations of computers. Compare analog & digital computers. Illustrate basic computer mathematics - binary code. Demonstrate or illustrate basic logic circuits: "and", "or", "nor" gates and "adders".	DEMONSTRATOR: DIGITAL AND/OR ANALOG COMPUTER MOCK-UP OF SINPLE LOGIC CIRCUITS P.44-F-21-"THINKING MACHINE" F-22-"MEMORY DEVICES" F-23-"ELECTRONIC COMPUTERS & APPLIE MATHEMATICS"

COURSE CONTENT	STUDENT ACTIVITY	TEACHER ACTIVITY	INSTRUCTIONAL AIDS
X. BASIC COMPUTER SYSTEMS continued		Discuss memory devices and systems; pulse controlled bi-stable multivibrator & flip-flop counting circuit.	
XI. EMPLOYMENT AND EDUCATIONAL OPPORTUNITIES			
Immediate employment versus advanced education in the field of electronics.	Make a self-evaluation profile of his own personal qualifications.	Discuss the relative advantages of immediate employment versus continued education.	SPEAKERS FROM INDUSTRY & COLLEGES SCHOOL COUNSELORS
Salary versus opportunity.	Make sample application for a job; written or personal. Select a school for continued education and make application to that school.	Compare the requisites for a high school graduate as a beginning employee to the requirements for continued education.	P.44-F-24-"THE ELECTRONICS WORKER" F-25-"THE TELEPHONE MAN" F-26-"CHOOSING YOUR OCCUPATION" F-27-"PERSONAL QUALITIES FOR JOB SUCCESS"
	Choose a particular area of interest within an occupational fields and field trips to local industry.	List types of jobs available for high school graduates, post high school and college graduates.	

APPENDIX

A: SAFETY RULES

"All the rules of general safety used in other school shops apply to the electrical shop."

1. "Electricity has no respect for ignorance." Be certain your instructor checks all projects before you apply voltage.

2. Do not work on any project with the power "ON."

3. If your project should blow a fuse in the main power line, do not turn it on until the trouble is discovered and remedied.

4. Avoid frayed cords, too many units running on one circuit, broken plugs, improper fuses, short circuits, metal top benches, damp or wet floors, improper conections or any careless activities.

5. Even though the power is off and disconnected, capacitors can still shock you. They must be discharged before working around them.

6. Avoid burns from soldering irons, tubes, resistors or shorted wires. Allow them to cool before handling them.

7. Know where the fire extinguishers are placed in your shop and know how to operate them.

8. Electronic test equipment can be destroyed by one wrong connection; therefore, ask permission before using any piece of test equipment.

9. In any instance of doubt, contact your instructor - BE SAFE.

NOTE: While most of the work done at the intermediate level will use low voltage, HIGH VOLTAGE precautions should apply.

B: FILMS, FILMSTRIPS FOR EXPLORING ELECTRICITY-ELECTRONICS

F-1 "THE MIGHT ATOM" 17 min., color, Arizona Public Service

F-2 "ELECTRICITY: PRINCIPLES OF SAFETY," 10 min., McGraw-Hill, U of A

F-3 "ON SAFETY WITH ELECTRICAL APPARATUS," 26 min., Cutler Hammer Co.

F-4 "FLOW OF ELECTRICITY" 10 min., b/w Young American 1962, ASU
"FLOW OF ELECTRICITY" 10 min., color (revised) McGraw-Hill code 401471

F-5 "ELECTRICITY: STATIC ELECTRICITY" 11 min., color, U of A

F-6 "INTRODUCTION TO ELECTRICITY" 10 min., b/w Coronet 1948, ASU & U of A

F-7 "ELECTRONS AT WORK" 14 min., color, EBF, 1961, U of A

F-8 "ELECTRON" 16 min., b/w UN-Govt. 1944, ASU

F-9 "PRINCIPLES OF ELECTRICITY" 120 min., color 16 mm, Free G.E.

F-10 "ELECTRICITY WORKS FOR US" 12 min., color, McGraw-Hill, ASU

F-11 "ELECTROSTATICS" 10 min., b/w EBF 1950, ASU

F-12 "AMPERES, VOLTS, AND OHMS" 8 min., USN/U of A

F-13 "MEASUREMENT OF ELECTRICITY" 12 min., U of A and USU Coronent 1949

F-14 "MAGNETISM" Coronet 12 min. U of A b/w
"MAGNETISM" EBF 10 min., b/w ASU

F-15 "MAKING ELECTRICITY" 11 min., b/w ASU

F-16 "PRIMARY CELL" 11 min., b/w ASU

F-17 "ELECTROMAGNET" 11 min., b/w ASU
"ELECTROMAGNETS" "HOW THEY WORK" 10 min., b/w EBF U of A

F-18 "PRINCIPLES OF THE GENERATOR" 10 min., b/w U of A and ASU

F-19 "ELECTRICITY: HOW IT IS GENERATED" 11 min., b/w Coronet U of A

F-20 "EDISON'S MIRACLE--YOU ARE THERE" 28 min., b/w Arizona Public Service

F-21 "THE LIGHT OF YOUR LIFE" color, 16mm, 120 min., Free from G.E.

F-22 "MOTORS ON PARADE" b/w 26 min., Free from G.E.

F-23 "WHAT IS ELECTRIC CURRENT?" color, 13 min. ASU

F-24 "DEVELOPMENT OF COMMUNICATION" 10 min., b/w EBF 1955 ASU

F-25 "MY POP'S A LINEMAN" 16 min., color, ASU

F-26 "ELECTRICIAN" 10 min., b/w U of A

F-27 "TELEPHONE AND TELEGRAPH" 10 min., b/w U of A

F-28 "ON SOLDER" 30 min., color, ASU

F-29 "RECEIVING RADIO MESSAGES" 10 min. sd, color ASU

APPENDIX B (continued)

SUGGESTED FILMSTRIPS

FS-1 "POWER FROM HYDRO-ELECTRICITY" By Herbert E. Budek Company Inc.

FS-2 "BASIC ELECTRICITY SERIES" The Jam Handy

2900 East Grand Blvd. Detroit, Mich.

C: REFERENCE BOOKS FOR EXPLORING ELECTRICITY-ELECTRONICS

1. Gerrish, Howard H., Electricity Goodheart-Willcox, Chicago, Ill. 1961
2. Cornetet, Wendell H., Principles of Electricity McKnight & McKnight, 1952
3. Steinberg, William B., Ford, Walter B., Electricity & Electronics-Basic American Technical Society, Chicago, Ill. 1964
4. U.S. Government Printing Office, Basic Electricity Washington D.C., 1960
5. Ford Motor Co. Fundamentals of Electricity-Training Handbook Course 13000
6. Marcus, Abraham, Basic Electricity Prentice Hall, New York, N.Y., 1964
7. Matson, D.E., Basic Electricity McKnight & McKnight, Bloomington, Ill.,1961
8. Buban, Peter; Schmitt, Marshall, Understanding Electricity & Electronics McGraw-Hill, New York, N.Y., 1962
9. Jones, E.W., General Electricity McKnight & McKnight, Bloomington, Ill., 1954
10. Arnold, Joseph F.; Schank, Kenneth L., Exploratory Electricity McKnight & McKnight, Bloomington, Ill., 1960
11. Miller, Rex; Culpepper, Fred, Experiences With Electrons McKnight & McKnight, Bloomington, Ill., 1966
12. Tustison, F. E.; Ruehl, P. W. Electrical Essentials for the Practical Shop Bruce Publishing Co., Milwaukee, Wisc., 1955
13. Gerrish, Howard H., Electronics Goodheart-Willcox, Chicago, Ill., 1961
14. 50 Easy To Build Projects Radio Shack, Cat. #62-1050, Boston, Mass.
15. Miller, Rex; Culpepper, Fred W. Jr., Energy Electricity Electronics McKnight & McKnight, Bloomington, Ill., 1963

D: TRANSPARENCIES

1. "MAGNETISM AND ELECTRICITY" Milliken Publishing Company, 611 Olive St. St. Louis, Missouri 63101 ($5.95)

2. "FUNDAMENTAL ELECTRICITY" 3 M Company, Education Services, Box 3100 St. Paul, Minnesota 55101

   Phoenix address: Hughes-Calihan Corporation
   4730 N. 16th Street
   Phoenix, Arizona 85231

3. "BASIC WIRING" 3 M Brand Transparencies

4. "ENERGY" Instructo Products Company, Division of Jacroda Mfg. Co. Philadelphia 31, Pa. 19131

5. "DCA" dca Educational Products Inc., Division of Display Corp. of America, 4865 Stenton Avenue, Philadelphia, Pa. 19144

E: OCCUPATIONAL GROUPS*

ELECTRICAL ENGINEER

Performs a variety of engineering work in designing, planning, and overseeing manufacture, construction, installation, operation and maintenance of electric or electronic components, equipment, systems, facilities, and machinery used in generation, transmission, distribution, and utilization of electrical energy for domestic, commercial and industrial consumption. A bachelor's degree in engineering is normally an entrance requirement. Graduate degrees in increasing demand.

ELECTRICITY-ELECTRONICS INSTRUCTOR

Teaches subjects in electricity-electronics to students in public, private, or industrial schools. Organizes program of practical and technical instruction, involving demonstrations of skills required in trade, and lectures on theory, practices, methods, processes, and terminology. Instructs students in safety precautions, mathematics, science, drawing, use and maintenance of tools and equipment and codes or regulations. Plans and supervises work of students in shop or laboratory. Tests and evaluates achievement of students in technical knowledge and skills. A bachelor's degree in education is a minimum entrance requirement except for vocational instructors who may substitute industrial experience plus required courses in education. Additional industrial experience plus required courses in education. Additional industrial experience and graduate degrees highly desired.

ELECTRONICS TECHNICIAN

Fabricates, assembles, adjusts, tests, and operates electrical or electronics devices conceived by scientists, designed by engineers. Typically they are salaried employees, working in the research, planning, development, and evaluation activities of the industry. Assists and supports engineers. Must have understanding of basic engineering principles learned in post-high school training in junior college, public and private technical institutes, college or university programs ranging from less than one year to four years. A two year associate degree program is most common.

ELECTRICAL ASSEMBLING, INSTALLING, AND REPAIRING OCCUPATIONS

Includes occupations concerned with assembling, installing, erecting, and repairing electrical equipment and related structures designed for electric power generation, transmission, and distribution; communication, signaling, and object detection; process control, fire control, and data processing; transportation and materials handling; heating, air conditioning, refrigeration and illumination; and other industrial, commercial; and domestic electrical applications. A high school education is a minimum for most such occupations. Courses in electricity-electronics highly desired. Specific training on-the-job provided by most companies. Advancement more likely through additional education.

*ADAPTED FROM THE DICTIONARY OF OCCUPATIONAL TITLES, 1965, THIRD EDITION

ELECTRICAL EQUIPMENT ASSEMBLY AND REPAIR OCCUPATIONS

Includes occupations concerned with assembling, fabricating, or repairing equipment, components, and parts for equipment to transmit, control, or convert electrical power; signaling and detection equipment, and home radios, television sets, and phonographs. A high school education with courses in electricity-electronics highly desired. An interest developed through hobby activities also desired. Specific training on-the-job provided by most companies. Advancement more likely through additional education.

ELECTRONIC COMMUNICATION, DETECTION, AND SIGNALING EQUIPMENT ASSEMBLY, INSTALLATION, AND REPAIR OCCUPATIONS

Includes occupations concerned with assembling equipment components; connecting and testing circuitry; installing equipment to provide electronic communication, detection, signaling, recording, analyzing, and computing services; and making on-site repairs in buildings, ships trains and aircraft. Requires vocational-technical education at high school and post-high school levels for most occupations; experience in related occupations desired. Specific training provided on-the-job by most companies.

ELECTRONIC TUBES AND LIGHT BULB ASSEMBLY OCCUPATIONS

Includes occupations concerned with fabricating and assembling filaments, grids, plates, masks, guns, and other parts inserting them into bulbs to complete electron tubes and light bulbs. High school education desired. Specific training provided on-the-job.

ELECTROPLATING OCCUPATIONS

Includes occupations concerned with covering the surfaces of objects by electro-deposition or electrolysis. High school education desired. Specific training provided on-the-job.

FABRICATION OF ELECTRICAL WIRE AND CABLE OCCUPATIONS

Includes occupations concerned with fabrication of bare, insulated, shielded, enameled, or waxed electrical conductors made from purchased wire. High school education desired. Specific training provided on-the-job.

SALESMAN AND SALESPERSONS, HOUSEHOLD APPLIANCES AND ELECTRICAL MACHINERY, EQUIPMENT, AND SUPPLIES

Includes occupations concerned with selling household appliances, electrical industrial apparatus, electric transmission and distribution equipment, electric lighting and wiring equipment, electronic components and accessories, radio and television sets, communications equipment. Knowledge of principles of electricity-electronics very helpful. Good communication skills required. High school education desired.

F: FILMS-FILMSTRIPS FOR GENERAL ELECTRICITY-ELECTRONICS

F-1 "ABC'S OF HAND TOOLS," General Motors, 30 min.

F-2 "BASIC ELECTRICITY," Bell Tel. & Tel., 20 min.

F-3 "PRINCIPLES OF ELECTRICITY," Gen'l. Electric, 20 min.

F-4 "WHAT IS ELECTRICITY," Westinghouse, 20 min.

F-5 "ELECTRICAL SAFETY IN THE HOME," Univ. of Utah, 14 min.

F-6 "SAFETY WITH ELECTRICITY," BYU, 10 min.

F-7 "SOURCES OF ELECTRICITY," Institutional Cinema Service, 11 min.

F-8 "VOLT-OHMMETER OPERATION," Civil Aeronautics Administration, 15 min.

F-9 "MEASUREMENT OF ELECTRICITY," U of Arizona, 22 min.

F-10 "AMPS, VOLTS AND OHMS," USN, 8 min.

F-11 "ELEMENTS OF ELECTRICAL CIRCUITS," ASU, 16 min.

F-12 "STORY OF THE MODERN STORAGE BATTERY," U of Arizona., 27 min.

F-13 "RADIO FREQUENCY INDUCTIVE HEATING," Westinghouse, 15 min.

F-14 "HIGH FREQUENCY SOLDERING," Univ. of Indianna, 17 min.

F-15 "INDUCTION HEAT," Allis Chalmers, 12 min.

F-16 "RF HEATING," Westinghouse, 40 min.

F-17 "ELECTROMAGNETS," Univ. of Indianna, 11 min.

F-18 "PRINCIPLES OF ELECTROMAGNETISM," Ideal Pictures, 20 min.

F-19 "PRINCIPLES OF MAGNETISM," Ideal Pictures, 20 min.

F-20 "BASIC ELECTRICITY: PARALLEL CIRCUITS AC," United World Films, 5 min.

F-21 "BASIC ELECTRICITY: AC SERIES CIRCUITS," United World Films, 4 min.

F-22 "SERIES AND PARALLEL CIRCUITS," Iowa State Univ., 11 min.

F-23 "BASIC ELECTRICITY: INDUCTORS IN AC CIRCUITS," United World Films, 7 min.

APPENDIX F (continued)

F-24 "INDUCTANCE," CAA, 35 min.

F-25 "THE ELECTRON AND INDUCTION," Bell Tel. & Tel., 18 min.

F-26 "TRANSFORMERS"(theory), (EBF), BYU, 30 min.

F-27 "TRANSFORMERS"(laboratory), (EBF), BYU, 30 min.

F-28 "THE IGNITION CIRCUIT," Champion Spark Plug Co., 11 min.

F-29 "BASIC ELECTRICITY: CAPACITANCE IN AC CIRCUITS," United World Films, 7 min.

F-30 "CAPACITANCE," CAA, 33 min.

F-31 "LIGHT AND POWER," BYU, 16 min.

F-32 "PRINCIPLES OF THE GENERATOR," Institutional Cinema Service, 11 min.

F-33 "MAGNETISM,"(EBF), Univ. of Ariz., 16 min.

F-34 "ELECTROMAGNETS," ASU, 10 min.

F-35 "PRINCIPLES OF THE GENERATOR," Univ. of Ariz., 10 min.

F-36 "ELECTRIC MOTORS," BYU, 30 min.

F-37 "PRINCIPLES OF THE STARTING MOTOR," Ft. Huachuca, 12 min.

F-38 "SINGLE AND POLYPHASE CIRCUITS,"BYU, 15 min.

F-39 "ROTATING MAGNETIC FIELDS,"BYU, 13 min.

F-40 "SQUIRREL CAGE ROTOR PRINCIPLES," BYU, 10 min.

F-41 "YOUR VOICE AND THE TELEPHONE," Bell Tel. & Tel. 7 min.

F-42 "TELEPHONE CABLE TO CUBA," Bell Tel. & Tel. 10 min.

F-43 "WINTER TOLL PATROL," Bell Tel. & Tel., 16 min.

F-44 "MORE THAN MEETS THE EYE," Bell Tel. & Tel., 14 min.

F-45 "COMMUNICATION," Indianna Univ., 15 min.

F-46 "DEVELOPMENT OF COMMUNICATION," Iowa State Univ., 10 min.

F-47 "RAILROADING BY RADIO," Harmon Electric Co., 25 min.

F-48 "RADIO OPERATOR," CAA, 20 min.

F-49 "HOW WE GET OUR POWER," Univ. of Ariz. 11 min.

F-50 "THE DIODE," Audio Films, 22 min.

F-51 "VACUUM TUBES, ELECTRON THEORY & DIODE TUBES," Iowa State Univ. 16 min.

F-52 "PHOTO EMISSION," McGraw-Hill, 19 min.

F-53 "VACUUM TUBE: TRIODE AND MULTIPURPOSE TUBES," United World Films, 14 min.

F-54 "PRINCIPLES OF THE TRANSISTOR," McGraw-Hill, 21 min.

F-55 "TRANSISTORS," Part I, US Army, 17 min.

FILM STRIPS

FS-1 "INDUCTANCE," United World Films

FS-2 "CAPACITANCE," United World Films

FS-3 "SPECIAL PURPOSE VACUUM TUBES," (sound) United World Films

G: FILMS FOR ELECTRONICS

F-1 "YOUR FUTURE IN ELECTRONICS," RCA Institute, 24 min.

F-2 "ELECTRICITY: PRINCIPLES AND SAFETY," Univ. of Ariz., 11 min. b/w

F-3 "ABC'S OF HAND TOOLS," Ariz. State Univ., 18 min. Color

F-4 "THE ELECTRONIC TECHNICIAN," Modern talking picture service

F-5 "ON SOLDER," Classroom Film Distributors

F-6 "OSCILLOSCOPE DRAWS A GRAPH," Tektronic Inc., 20 min. b/w

F-7 "OSCILLOSCOPE: WHAT IT IS: WHAT IT DOES," Tektronix Inc., 9 min. b/w

F-8 "MEASUREMENTS OF ELECTRICITY," Univ. of Ariz., 22 min. b/w

F-9 "CIRCUIT TESTING WITH METERS AND MULTIPLIERS: PRACTICAL APPLICATIONS," 33 min. Army or Univ. of Iowa b/w

F-10 "THE DIODE: PRINCIPLE AND APPLICATIONS," 17 min. Univ. of Ill., b/w

F-11 "THE PRINCIPLES OF THE GAS FILLED TUBE," 15 min., Univ. of Ill. b/w

F-12 "VACUUM TUBES,"(physics series), BYU, 30 min. Color

F-13 "OHM'S LAW," 6 min., b/w Univ. of Ariz., Univ. of Ill.

F-14 "SERIES AND PARALLEL CIRCUITS," 11 min. Univ. of Ariz. b/w

F-15 "AC THEORY, ELECTRICITY & MAGNETISM #23," BYU, 30 min., b/w

F-16 "TRIODE, AMPLIFICATION," 14 min., Univ. of Ill., b/w

F-17 "CATHODE RAY TUBE," 25 min., Tektronix, Inc., b/w

F-18 "INDUCTANCE," (radio tech. training), Univ. of Ill., 33 min. b/w

F-19 "INDUCED ELECTRIC CURRENTS," BYU, 30 min. b/w

F-20 "CAPACITANCE," (electricity & magnetism), Univ. of Ill., 30 min. b/w

F-21 "CAPACITANCE," (physics series), BYU, 30 min. b/w

F-22 "RCL: RESISTANCE, CAPACITANCE,"(radio tech. training) Univ. of Ill., 30 min. b/w

F-23 "VECTORS," (radio tech. training), Univ. of Ill., 11 min., b/w

F-24 "RADIO WAVES," BYU, 27 min. b/w

APPENDIX G (continued)

F-25 "OSCILLATORS, AMPLIFIERS AND RADIO," (electronics #4), Univ of Ill., 30 min. b/w

F-26 "RADIO WAVES," Arizona State University, 27 min.

F-27 "OSCILLATORS, AMPLIFIERS AND RADIO," (electronics lesson #4) University of Ill., 30 min.

F-28 "PRINCIPLES OF THE TRANSISTOR," University of Ill., 22 min.

F-29 "YOUR FUTURE IN ELECTRONICS," RCA, 24 min.

F. FILMS FOR ADVANCED ELECTRONICS

F-1 "ELECTRICITY - PRINCIPLES OF SAFETY" Coronet

F-2 "SAFETY WITH EVERY DAY TOOLS" Coronet

F-3 "ELECTRICAL SAFETY IN THE HOME" Brigham Young University, 20 min.

F-4 "SAFETY PRECAUTIONS FOR ELECTRONIC PERSONNEL" Univ. of Ill., 20 min.

F-5 "PRINCIPLES OF THE TRANSISTOR" University of Illinois, 22 min

F-6 "THE TELEVISION SYSTEM" McGraw Hill

F-7 "TELEVISION SYSTEM" McGraw Hill

F-8 "PRACTICAL TV ALIGNMENT" McGraw Hill

F-9 "TELEVISION-HOW IT WORKS" ASU, (Coronet), 11 min.

F-10 "BASIC PRINCIPLES OF FREQUENCY MODULATION" U.S.Army-Ft. Huachuca, 31 min.

F-11 "OSCILLATORS" U.S.N./United World Films, 28 min.

F-12 "RADIO TRANSMITTER PRINCIPLES" University of Ill. 17 min.

F-13 "ELECTROMAGNETIC WAVES" ASU (Encyclopedia Britannica Films), 30 min.

F-14 "EFFECTS OF THE IONOSPHERE ON RADIO WAVE PROPAGATION" U. S. Army Ft. Huachuca, 29 min.

F-15 "MIRROR IN THE SKY" University of Colorado, 22 min.

F-16 "TRANSMISSION LINES" Tektronics, 23 minutes

F-17 "STANDING WAVES ON TRANSMISSION LINES" Univ. of Ill., 22 min.

F-18 "AUTOMATIC MACHINES" Massachusetts Institute of Technology, 26 min.

F-19 "RADAR AND TV" Encyclopedia Britannica Films

F-20 "COAXIAL AND MICROWAVE MIRACLES" University of Colorado, 10 min.

F-21 "THINKING MACHINE" Arizona State University, 20 min.

F-22 "MEMORY DEVICES" University of Arizona, 29 min.

F-23 "ELECTRONIC COMPUTERS AND APPLIED MATHEMATICS" Univ. of Col., 23 min.

F-24 "THE ELECTRONIC WORKER" Modern Talking Picture Service

F-25 "THE TELEPHONE MAN" Modern Talking Picture Service

F-26 "CHOOSING YOUR OCCUPATION" Coronet

F-27 "PERSONAL QUALITIES FOR JOB SUCCESS" Coronet

I: CHARTS AND TRANSPARENCIES FOR ELECTRICITY-ELECTRONICS

C-1 Alternating Current Group (11 charts) ACG.* Electronic Kits supply Company. 423 East 4th Street, Los Angeles, California 90013.

C-2 Transistor Circuits TCG (same source as C-1)

T-1 Alternating Current DCA E-55-57. Display Corporation of America, 4865 Stenton Avenue, Philadelphia, Pennyslvania 19144.

T-2 Antennas DCA E-101 (same source as T-1)

T-3 Radar DCA E-104 (same source as T-1)

* One of 10 groups available @ $16.95

ADVANCED ELECTRONICS

ELECTRICITY-ELECTRONICS

1. Buban & Schmitt, Understanding Electricity & Electronics, 1962, McGraw-Hill Book Company

2. Cornetet & Cornetet, Principles of Electricity & Basic Electronics, 3rd edition, 1963, McKnight & McKnight Publishing Company

3. Ford & Steinberg, Electricity & Electronics, 3rd edition, American Technical Society

4. Gerrish, Electricity & Electronics, 1964, McGraw-Hill Book Company

5. Graham, Fundamentals of Electricity, 4th edition, American Technical Society

6. Lush & Engle, Industrial Arts Electricity, Chas. A. Bennett Co., Inc.

7. Marcus, Basic Electricity, 2nd edition, 1964, Prentice-Hall, Inc.

8. Miller & Culpepper, Energy, Electricity & Electronics, 1964, McKnight & McKnight Publishing Company

9. Suffern, Basic Electrical & Electronic Principles, 1962, McGraw-Hill Book Company

ELECTRONICS

1. Cooke, Electronics & Nucleonics Dictionary, McGraw-Hill Book Company

2. Evans & Porter, Experimental Basic Electronics, 1958, McKnight & McKnight Publishing Company

3. Kuehn, Mathematics for Electricians, 3rd edition, 1958, McGraw-Hill Book Company

4. Marcus, Basic Electronics, 1964, Prentice-Hall, Inc.

5. Marcus, Elements of Radio, 5th edition, 1965, Prentice-Hall, Inc.

6. Philco Staff, Electricity & Electronic Fundamentals, vols. 1,2,3, 1960, Philco

7. Slurzberg & Osterheld, Essentials of Electricity-Electronics, 3rd edition, 1965, McGraw-Hill Book Company

8. Van Valkenburgh, Nooger & Neville, Basic Electronics, vols. 1,2, 1959 Hayden Book Companies

ADVANCED ELECTRONICS

1. Alverez & Fleckles, Introduction to Electron Tubes & Semiconductors, 1965, McGraw-Hill Book Company

2. ARRL Staff, Antenna Book, American Radio Relay League

APPENDIX J (continued)

ADVANCED ELECTRONICS

3. ARRL Staff, Radio Amateur Handbook, Current Issue, American Radio Relay League

4. Grob, Basic Electronics, 2nd edition, 1965, McGraw-Hill Book Co.

5. Grob, Basic Television, 3rd edition, 1964, McGraw-Hill Book Co.

6. Grob & Kiver, Applications of Electronics, 1966, McGraw-Hill Book Co.

7. Hunter, Handbook of Semiconductor Fundamentals, McGraw-Hill Book Co.

8. Romaniwitz, Fundamentals Of Semiconductors & Tubes, 1962, Wiley Publishing Company

9. Slurzberg & Osterheld, Essentials of Radio - Electronics, 2nd edition, 1961, McGraw-Hill Book Company

10. Van Valkenburgh, Nooger & Neville, Basic Electronics, vols. 3,4,5, 1959, Hayden Book Companies

11. Watson, Welch & Eby, Understanding Radio, 3rd edition, 1960, McGraw-Hill Book Company